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Effect of Potassium and zinc on nutrient uptake on pigeon pea (*Cajanus cajan* L. Millsp.)

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Abstract
A field experiment was conducted at research farm, Department of soil science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani University to study effect of application of varying levels of potassium and zinc on productivity, nutrient uptake and quality parameters of pigeon pea during 2017-2018. Highest uptake was recorded with combined application of 30 kg K_2O + 15 kg $ZnSO_4$ along with recommended dose of NPK fertilizers (RDF) and was at par with application of 15 kg K_2O + 15 kg $ZnSO_4$ along with RDF and at par with 45 kg K_2O + 15 kg $ZnSO_4$ with RDF.

Keywords: Pigeon pea, potassium, zinc, nutrient uptake

Introduction

A field experiment was conducted at research farm, Department of soil science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani University to study effect of application of varying levels of potassium and zinc on productivity, nutrient uptake and quality parameters of pigeon pea during 2017-2018. Highest uptake was recorded with combined application of 30 kg K_2O + 15 kg $ZnSO_4$ along with recommended dose of NPK fertilizers (RDF) and was at par with application of 15 kg K_2O + 15 kg $ZnSO_4$ along with RDF and at par with 45 kg K_2O + 15 kg $ZnSO_4$ with RDF.

Pulses form an integral part of vegetarian diet in Indian subcontinent. Besides being rich source of protein, they maintain soil fertility through biological nitrogen fixation, improves the soil organic matter by defoliation at the time of maturity. Hence, they occupy prominent place in various cropping system and crop mixtures, and thus pulses play a vital role in sustainable agriculture. To alleviate the problem of protein malnutrition in the country, it is very much imperative to enhance the production of pigeon pea, as it is an important pulse crop in the country as well as in the state.

During green revolution high yielding varieties introduced to meet the demand of food for growing population resulted in the depletion of soil nutrients status. Pigeon pea is mainly grown in almost all the states and larger portion of the area is in the states like Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka and Gujarat. It is grown throughout the tropical and subtropical region of the world, between 30 N and 35 S latitudes. However, major area under pigeon pea in India is lying between 14 S and 28 N latitudes.

The function of potassium in plant metabolism is different from that of other major nutrients. The later become part of the plant structure, whereas potassium largely remains as an ion in the cells and sap and helps to control the water intake and metabolism of the plant. Some of the specific effects of potassium are to increase root growth and improve drought resistance. (Ranade, 2011) [9].

Zinc is one of the seventh plant micronutrient, involved in many enzymatic activities of the plant. It functions generally as a metal activator of enzymes. It is reported that, zinc improves crop productivity almost as much as major nutrients. Besides increasing crop yield, it increases the crude protein content, amino acids, energy value and total lipid in chickpea, soybean, black gram etc. Zinc deficiency is wide spread, in Marathwada region and it varies between 62 to 89 %.

The Zn plays very important role in plant metabolism by influencing the activities of hydrogenise and carbonic anhydrate, stabilization of ribosomal fractions and synthesis of cytochrome. Plant enzymes activated by Zn are involved in carbohydrate metabolism, maintenance of the integrity of cellular membranes, protein synthesis, regulation of auxin synthesis and pollen formation. The regulation and maintenance of the gene expression required for the tolerance of environmental stresses in plants are Zn dependent. Its deficiency resulted in development of abnormalities in plants which become visible as deficiency symptoms such as stunted growth, chlorosis and smaller leaves, spikelet sterility. Zn deficiency can also adversely affect the quality of harvested products, plants susceptibility to injury by high light or temperature intensity and infection by fungal diseases can also increase. Zinc seems to affect the capacity for water uptake and transport in plants and also reduce the adverse effects of short periods of heat and salt stress. As Zn is required for the synthesis of tryptophan which is a precursor of IAA, it also had an active role in production of an essential growth hormone auxin. The Zn is required for integrity of cellular membranes to preserve the structural orientation of macromolecules and iron transport systems.

Materials and Methods

A field experiment was conducted during *kharif* season 2017-2018 to study the influence of varying levels of potassium and zinc on yield attributes and soil nutrient dynamics in pigeon pea at Research Farm, Department of Soil Science and Agricultural Chemistry, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was counducted in randomized block design with plot size of 5.4×4.2m^2 and 8 treatments were T_1: Absolute control (No fertilizer), T_2: Only RDF (25:50 N and P_2O_5 kg ha^{-1}), T_3: RDF + 15 kg K_2O ha^{-1}, T_4: RDF + 30 kg K_2O ha^{-1}, T_5: RDF + 45 kg K_2O ha^{-1}, T_6: RDF + 15 kg K_2O ha^{-1} + 15 Kg $ZnSO_4$ha^{-1}, T_7: RDF + 30 kg K_2O ha^{-1} + 15 Kg $ZnSO_4$ha^{-1}, T_8: RDF + 45 kg K_2O ha^{-1} + 15 Kg $ZnSO_4$ha^{-1}. Pigeon pea variety BSMR – 736 was sown in rows 90 cm and plant 20 cm. Application of K and Zn at sowing. One irrigation at the time of flowering were provided. The RDF viz., 25: 50 kg ha^{-1} N, P_2O_5, was applied to pigeon pea during the following kharif season. The seed of pigeon pea variety BSMR - 736 was sown by dibbling at distance 90 cm x 20 cm, gap filling was done 10 days after sowing to maintain plant population. Schedule of cultural operations were carried out as per recommendation.

Results and Discussion

The data pertaining to nitrogen, phosphorus and potassium uptake by pigeon pea with respect to influence of varying levels of potassium and zinc application is presented in Table 1. and fig 1.

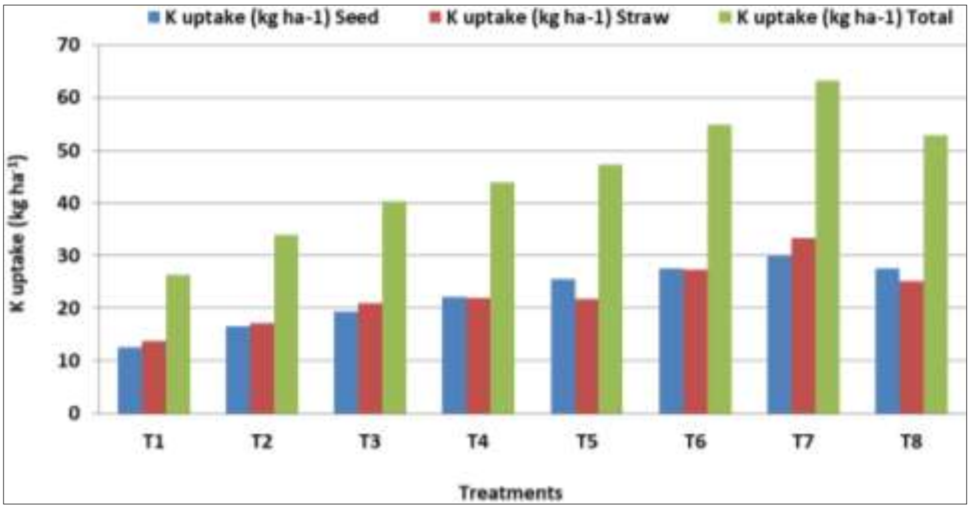

Fig 1: Influence of varying levels of potassium and zinc application on potassium uptake.

Table 1: Influence of varying levels of potassium and zinc on nutrient uptake of N, P, K, at critical growth stages of pigeon pea.

Treatments		N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
		Seed	Straw	Total	Seed	Straw	Total	Seed	Straw	Total
T_1	Absolute control	24.95	17.64	42.59	3.87	4.09	7.96	12.52	13.72	26.24
T_2	Only RDF (25:50 N and P_2O_5 kg ha^{-1})	30.17	33.57	63.74	5.08	6.54	11.62	16.62	17.22	33.84
T_3	RDF + 15 kg K_2O ha^{-1}	34.16	31.92	66.08	5.83	6.99	12.82	19.40	20.97	40.37
T_4	RDF + 30 kg K_2O ha^{-1}	38.36	40.10	78.46	6.61	7.62	14.23	22.09	21.89	43.98
T_5	RDF + 45 kg K_2O ha^{-1}	46.76	40.41	87.17	7.87	7.53	15.40	25.46	21.83	47.29
T_6	RDF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}	53.48	44.63	98.11	8.57	8.51	16.76	27.61	27.34	54.95
T_7	RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}	59.48	50.92	110.4	9.21	9.38	18.59	29.99	33.23	63.22
T_8	RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}	55.47	43.85	99.32	8.32	7.59	15.91	27.57	25.23	52.80
	Grand Mean	42.85	37.88	80.73	6.90	7.28	14.16	22.65	22.67	45.33
	SEm (±)	7.53	2.84		2.18	1.21		3.51	2.51	
	CD at 5%	22.81	8.61		6.92	3.67		10.63	7.61	

N uptake

The plant nitrogen uptake was ranged from 24.95 to 59.48 Kg ha^{-1} in seed and straw it was ranged from 17.64 to 50.92 Kg ha^{-1} respectively. The treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) recorded maximum value of N uptake (59.48 kg ha^{-1}) and it was at par with treatment T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and T_6 (RDF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) over absolute control and in only RDF treatment T_2. In seed, treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) (59.48 kg ha^{-1}), recorded maximum uptake of N and found to be at par with treatment T_6 RDF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1} and T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and it was significantly superior over control and only RDF. Kherawat *et al.* (2013) [7], Chavan *et* *al.* (2012) and Keram and Singh (2014) [6] also reported similar findings.

P uptake

The data presented in Table 4.13. Revealed that, the plant phosphorus uptake was ranged from 3.87 to 9.21 Kg ha^{-1} in seed and straw it was ranged from 4.09 to 9.38 Kg ha^{-1} respectively. There was significant increase in P uptake by pigeon pea with application of potassium and zinc over control and only RDF. The highest p uptake in plant was noticed in treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and it was at par with treatment T_6 (DF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}), T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}). The highest P uptake in seed recorded with in treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and it was at par with treatment T_6 (DF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}).

K uptake

The data presented in Table 4.13. and fig 4.4 revealed that, the K uptake was influenced due to K and Zn application. The potassium uptake was ranged between 12.52 to 29.99 Kg ha^{-1} and in seed and straw it was 13.72 to 33.23 Kg ha^{-1}. The maximum total potassium uptake (63.22 Kg ha^{-1}) was seen in treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) followed by treatment T_6 (DF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}). In seed, the maximum K uptake (29.99 Kg ha^{-1}) was observed in treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) followed by treatment T_6(DF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}). Similarresults were also reported by Kherawat *et al*. (2013) [7], Brar *et al*. (2010) [2], Jat *et al*. (2013) [5], Chavan *et al.* (2012) and Keram and Singh (2014) [6].

Table 2: Influence of varying levels of potassium and zinc on Fe and Zn nutrient uptake of pigeon pea

Treatments		Zn uptake g ha^{-1}		
		Seed	Straw	Total
T_1	Absolute control	29.70	36.60	66.30
T_2	Only RDF (25:50 N and P_2O_5 kg ha^{-1})	39.94	52.38	92.32
T_3	RDF + 15 kg K_2O ha^{-1}	48.66	57.50	106.16
T_4	RDF + 30 kg K_2O ha^{-1}	49.55	69.69	119.24
T_5	RDF + 45 kg K_2O ha^{-1}	62.23	66.38	128.61
T_6	RDF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}	72.74	94.37	167.11
T_7	RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}	78.56	104.14	182.70
T_8	RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}	69.80	79.28	149.08
	Grand Mean	56.39	70.04	
	SEm (±)	4.57	9.11	
	CD at 5%	13.85	27.61	

Zn uptake

The data indicated that, the increasing the levels of potassium at 45 kg ha^{-1} with RDF and zinc at 15 kg ha^{-1} resulted in higher uptake of zinc Table 2. and fig 2. The zn uptake by plant and seed increased from 29.70 to 78.56 g ha^{-1} in seed and in straw it was ranged from 36.60 to 104.14 g ha^{-1}. The application of RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1} recorded significantly higher Zn uptake in plant followed by treatment T_6 (RDF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}), and T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}). Significant highest value of Zn uptake in seed (104.14 g ha^{-1}) was noticed in treatment T_7 (RDF + 30 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) followed by T_6 (RDF + 15 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}) and T_8 (RDF + 45 kg K_2O ha^{-1} + 15 kg $ZnSO_4$ ha^{-1}). Similar results were also noticed by Chavan *et al.* (2012).

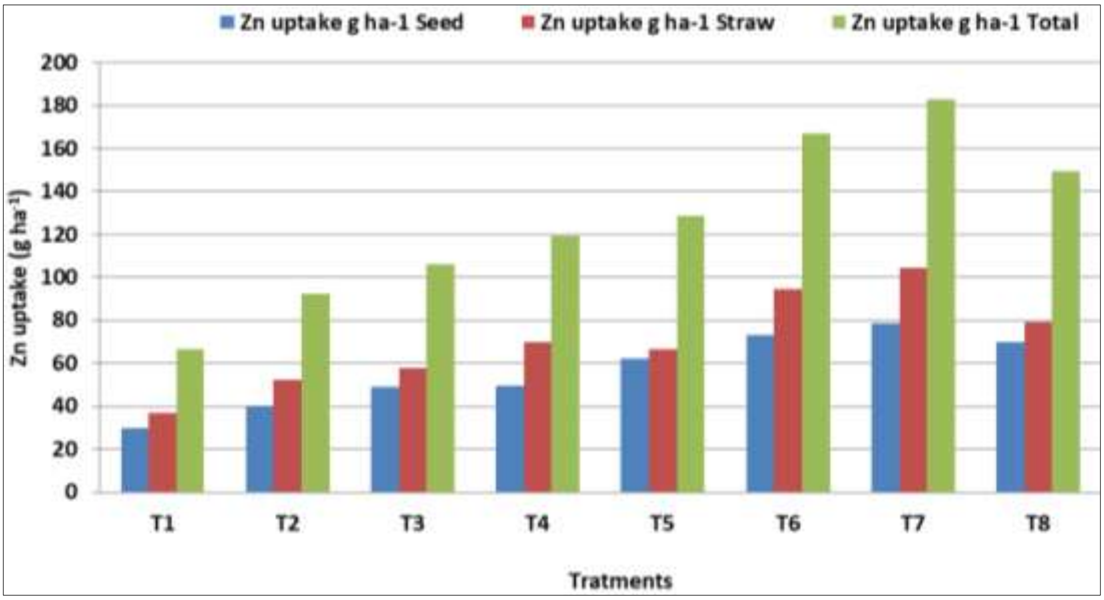

Fig 2: Influence of varying levels of potassium and zinc application on zinc uptake

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